

REMARKS

Favorable reconsideration of this application, as presently amended and in light of the following discussion, is respectfully requested.

Claims 1, 2, 4-7, 9-15, and 18-20 are currently pending. Claims 3 and 8 have been canceled without prejudice; Claims 1, 9, 10, 13, 18, and 19 have been amended; and Claim 20 has been added by the present amendment. The changes and additions to the claims are supported by the originally filed specification and do not add new matter.

In the outstanding Office Action, Claims 1-3, 5, 7, 8, 10, 12, 13, 15, 18, and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Application No. 2001/002430 to Honma et al. (hereinafter “the ‘430 patent”) in view of U.S. Patent No. 6,044,667 to Chenoweth (hereinafter “the ‘667 patent”), Japanese Patent Application No. JP 56-31188 to Sato (hereinafter “the ‘188 patent”), U.S. Patent No. 5,364,426 to Richards (hereinafter “the ‘426 patent”), U.S. Patent No. 3,997,316 to Koontz (hereinafter “the ‘316 patent”), further in view of U.S. Patent No. 3,806,621 to Machlan (hereinafter “the ‘621 patent”); Claims 13 and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Application No. 02-188489 to Watanabe et al. (hereinafter “the ‘489 patent”) in view of the ‘644, ‘188, and ‘426 patents; Claims 4, 6, 9, 11, and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the ‘430, ‘667, ‘188, ‘426, ‘316, and ‘621 patents, further in view of U.S. Patent No. 6,886,364 to Ohama et al. (hereinafter “the ‘364 patent”); and Claim 14 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the ‘489, ‘667, ‘188, ‘429, and the ‘364 patents.

Amended Claim 1 is directed to a process of reforming a quartz glass crucible, wherein the quartz glass crucible is reformed by an arc discharge generated by electrodes positioned around a rotational axis and configured to heat an inside surface of the crucible while the crucible is rotated, the process comprising:

using an electrode structure having $3n$ electrodes with 3-phase alternating electric current, n being equal to or larger than 2, wherein neighboring electrodes are positioned at regular intervals from each other in a ring-like configuration so as to form a stable ring-like arc between the neighboring electrodes, without generating a continuous arc between electrodes facing each other across a central portion of the ring-like configuration, wherein a diameter of the crucible is 28 inches or more, and a radius r of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R for at least a fixed time during arc heating;

heating the inside surface of the crucible while the crucible is rotated wherein a radius r of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R , for at least a fixed time during arc heating; and

removing one of a foreign substance located on the inside surface and a bubble located under the inside surface by arc discharge.

The changes to Claim 1 are supported by the originally filed specification and do not add new matter.¹

In a non-limiting example, the effects of the invention recited in Claim 1 are explained in the present specification. As shown in Table 1, while the bubble content in the wall portion after reforming treatment of Comparison Example 1 using three electrodes was 0.50%, the bubble content after reforming treatment of Example 1 using six electrodes was 0.03%. The bubble content was decreased by 94%.

Furthermore, as shown in Table 2, while the number of foreign substances after reforming treatment of Comparison Example 2-1 using three electrodes was 22, the number of foreign substances after reforming treatment of Example 2 using six electrodes was decreased to zero. Regarding the bubble content and the number of foreign substances on a

¹ See, e.g., original Claim 3, as well as the example in Table 1, which illustrates a crucible having a diameter of 32 inches and the electrode ring-like configuration being up to 500 mm in diameter. See also page 9, lines 7-10.

bottom portion of the crucible, no substantial difference was observed between the examples and the comparison examples.

Moreover, the invention of Claim 1 was completed by discovering these phenomena characteristic in an inner side wall portion of large-sized quartz glass crucible of a diameter of 28 inches or more.

Applicants respectfully submit that the rejection of Claim 1 under 35 U.S.C. § 103(a) is rendered moot by the present amendment to that claim.

Regarding the rejection of Claim 1 under 35 U.S.C. § 103(a), the Office Action asserts that the '430 and '667 patents disclose everything in Claim 1 with the exception of the electrode structure, and relies on the '188, '426, '316, and '621 patents to remedy that deficiency.

The '430 patent is directed to a quartz glass crucible for pulling up a silicon single crystal by feeding a powdery quartz raw material into a rotating mold, forming a formed body having a crucible shape, arc melting the formed body to obtain a quartz glass crucible, and further mechanically grinding the whole inner surface of the quartz glass crucible and re-melting the inner surface by arc melting or high frequency plasma flame melting.

However, as admitted in the outstanding Office Action, the '430 patent fails to disclose the arrangement of electrodes recited in Claim 1, and that the radius of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of the open portion of the crucible, but not greater than R, for at least a fixed time during arc heating, as recited in amended Claim 1.

The '667 patent is directed to a system for melting and delivering glass to a work area such as spinners for making fiberglass including a melter, and a melter for melting glass from batch material to form a pool of molten glass including the bottom wall, inside wall, and at least one discharged port. As shown in Figure 1A, the '667 patent discloses six electrodes

equally spaced in a circular pattern about the center of a cylindrical tank. Further, the '667 patent discloses that the plurality of electrodes are arranged within the molten pool so as to generate a "hot spot" of molten glass.

However, Applicants respectfully submit that the '667 patent fails to disclose the electrode configuration recited in Claim 1, wherein neighboring electrodes are positioned at regular intervals from each other as to form a stable ring-like arc between the neighboring electrodes, without generating a continuous arc between electrodes facing each other across a central portion of the ring-like configuration, as required by Claim 1. Further, Applicants respectfully submit that the '667 patent fails to disclose that a radius of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, as recited in amended Claim 1. In this regard, Applicants note that the '667 patent discloses that the radius R_1 shown in Figure 1A is $\frac{1}{4}$ - $\frac{1}{3}$ of the radius R_2 .²

Moreover, as disclosed by the '667 patent, the technical concept of electrodes immersed in a fused glass for heating the fused glass is completely different from that of electrodes arranged in the atmosphere inside a quartz glass crucible for heating the inner wall of the crucible. In the glass fusing furnace, the discharging electrodes are immersed in the fused glass in the furnace, and the discharge formed between the electrodes heats the liquid glass surrounding the electrodes. Therefore, in this case, the technical concept of uniformly heating the inner wall of the furnace (corresponding to the inner wall of the crucible) does not exist.

The '188 patent is directed to arc welding method for a welding unit having a comparatively short welding seem length. The '188 patent discloses plural electrodes connected via an arc stabilizing apparatus at the output end for each phase of a multiphase

² See '667 patent, column 7, lines 23-25.

alternating current power source, wherein each electrode is connected to an output terminal of one phase of the alternating current power source, and is adjacent to an electrode that is connected to an output terminal of another phase of the alternating current power source. However, Applicants respectfully submit that the '188 patent fails to disclose that a radius of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, as recited in amended Claim 1. Moreover, in the '188 method, the electrodes are arranged outside the ring-shaped article for heating the ring-shaped article placed inside the electrodes. Therefore, the technical concept of the electrodes of the '188 patent is completely different from the electrodes in Claim 1.

The '426, '316, and '621 patents are directed to various glass melting furnaces having various arrangements of electrodes. For example, the '426 patent discloses configurations in which six or nine electrodes are arranged at a general circular pattern. Further, the '316 patent discloses that different phases can be used to accommodate a particular arrangement of electrodes, but is nonspecific in this regard. Further, the '621 patent discloses that the design of a furnace 50 can be adapted to a two-phase power source or to other multiphase power sources having more than three phases. However, the Applicants note that the arrangement of the electrodes disclosed by the '621 patent is not circular.

However, Applicants respectfully submit that the '426, '316, and '621 patents fail to disclose that a radius of a ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, as recited in amended Claim 1. In particular, Applicants note that the text of the '426 and '621 patents fails to even contain the word "radius" or "diameter."

Thus, no matter how the teachings of the '430, '667, '188, '426, '316, and '621 patents are combined, the combination does not teach or suggest that a diameter of the crucible is 28 inches or more, and a radius of a ring-like configuration around the rotational

axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, for at least a fixed time during arc heating, as recited in amended Claim 1. Accordingly, Applicants respectfully submit that the rejection of Claim 1 is rendered moot and that Claim 1 patentably defines over any proper combination of the cited references.

Moreover, Applicants note that in the conventional reforming process of quartz glass crucibles, an arc discharge formed by applying three phase current to three electrodes had been considered to be sufficient for heating the inner wall of the crucible. Contrary to this common sense, the present inventors discovered the above-mentioned phenomena characteristic in an inner side wall portion of a large-sized quartz glass crucible of a diameter of 28 inches or more, and completed the invention of Claim 1. If not for discovering the above phenomena, the motivation for forming a ring-like arc by increasing the number of electrodes to $3n$ ($2 \leq n$) and setting a radius r of the ring-like configuration around the rotational axis in at least $\frac{1}{4}$ and not greater than 1 of a radius R of an opening of the crucible cannot arise. Therefore, the combination of the cited references is based only on hindsight reconstruction.

Independent Claims 13, 18, and 19 recite limitations analogous to the limitations recited in Claim 1, and have been amended in a manner analogous to the amendment to Claim 1. Accordingly, for the reasons stated above for the patentability of Claim 1, Applicants respectfully submit that the rejections of Claims 13, 18, and 19 are rendered moot by the present amendment to those claims.

Regarding the rejection of Claim 13 under 35 U.S.C. § 103(a) as being unpatentable over the '489, '667, '188, and '426 patents, Applicants note that, as discussed above, the '667, '188, and '426 patents fail to disclose the radius limitation recited in amended Claim 1. Further, Applicants note that the '489 patent is directed to a method for regenerating a quartz crucible for pulling up silicon single crystal. However, as admitted in the outstanding Office

Action, the '489 patent fails to disclose the electrode structure recited in Claim 13. Further, Applicants respectfully submit that the '489 patent fails to disclose that a radius of a ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, as recited in amended Claim 13.

Thus, no matter how the teachings of the '489, '667, '188, and '426 patents are combined, the combination does not teach or suggest that a diameter of the crucible is 28 inches or more, and a radius of the ring-like configuration around the rotational axis is at least $\frac{1}{4}$ of a radius R of an open portion of the crucible, but not greater than R, as recited in amended Claim 13. Accordingly, Applicants respectfully submit that the rejection of Claim 13 is rendered moot, and that Claim 13 patentably defines over any proper combination of the cited references.

Regarding the rejection of dependent Claims 4, 6, 9, 11, and 14 under 35 U.S.C. § 103(a), Applicants respectfully submit that the '364 patent fails to remedy the deficiencies of the '430, '667, '188, '426, '316, '621, and '489 patents, as discussed above. Accordingly, Applicants respectfully submit that the rejections of the above-noted dependent claims are rendered moot by the present amendment to Claims 1 and 13.

The present amendment also sets forth new Claim 20 for examination on the merits. New Claim 20, which depends from Claim 1, clarifies that the radius r is at least $\frac{1}{2}$ of the radius R. New Claim 20 is supported by the originally filed specification and does not add new matter.³

Thus, it is respectfully submitted that independent Claims 1, 13, 18, and 19 (and all associated dependent claims) patentably define over any proper combination of the cited references.

³ See, e.g., Table 1.

Consequently, in view of the present amendment and in light of the above discussion, the outstanding grounds for rejection are believed to have been overcome. The application as amended herewith is believed to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

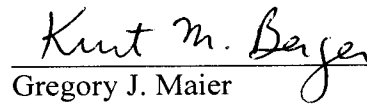
Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, L.L.P.

Customer Number

22850

Tel: (703) 413-3000
Fax: (703) 413-2220
(OSMMN 06/04)



Gregory J. Maier
Attorney of Record
Registration No. 25,599

Kurt M. Berger, Ph.D.
Registration No. 51,461

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